

XML-based Configuration Management for IP Network Devices

**DPNM Lab
Hyoun-Mi Choi
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siwa@postech.ac.kr**

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Introduction



- As the Internet continues to grow
 - IP networks are complex and composed of diverse network devices
 - the network management of IP networks are becoming more and more difficult
- Problem in SNMP-based Network Management
 - Limited Management Information Modeling: SMI MIB
 - Not support structured data types, objects, or methods
 - Not support to present the relationships among managed objects
 - Limited Management Protocol: SNMP
 - Not support to provide various operations to improve management functionalities (Get/Set/Trap/Getbulk)
 - Not support to retrieve a large volume of data using SNMP over UDP

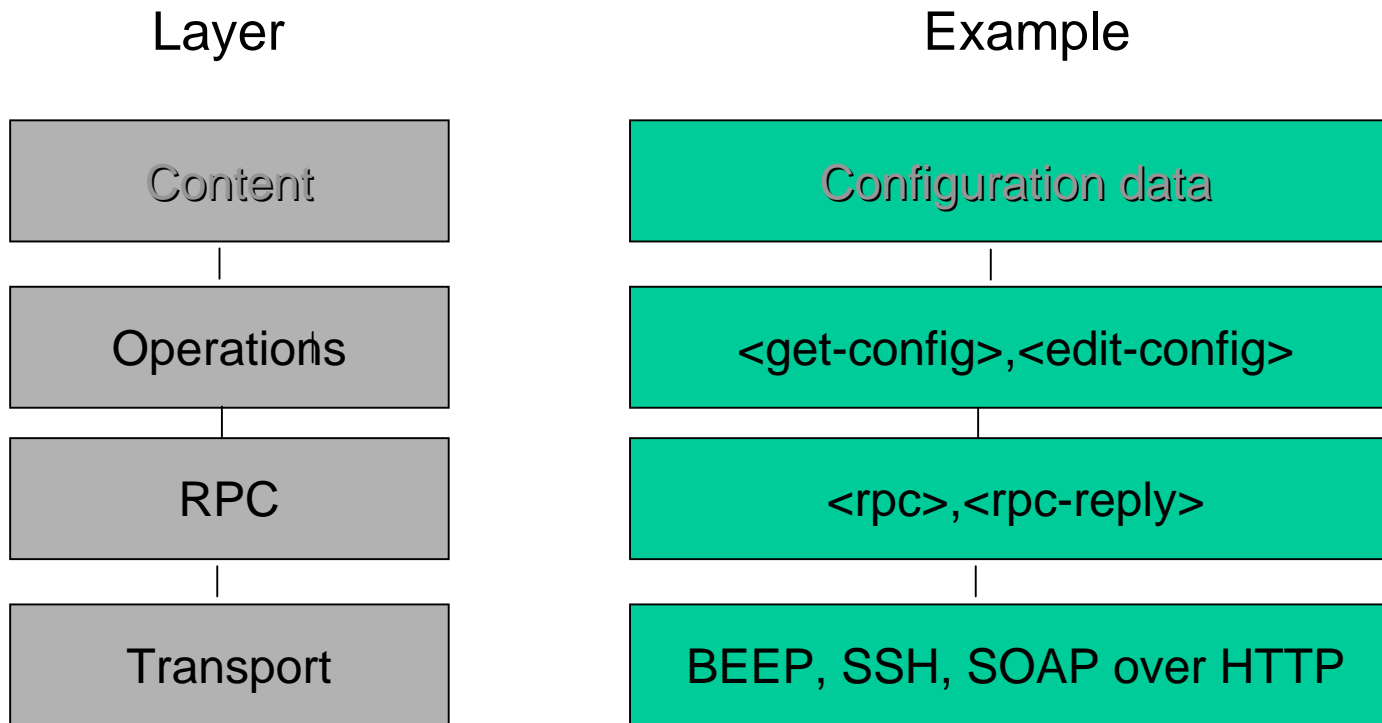
Introduction (2)

- SNMP Problem for Configuration Management
 - Need to process bulk data (no *setbulk* operation)
 - Provide static addressing method to map every object to the OID number
 - Provide complex relationships between managed objects
 - Revolutionary approach to solve the existing problems
 - Management Information Modeling considering **relationships**
 - Management Protocol using **SOAP**
 - Addressing Method: **XPath**
- => Propose Architecture of XML-based Configuration Management System (**XCMS**)

Overview of Netconf

- A working group in IETF which was formed in May 2003
- Standardize XML-based management protocol message to provide interoperability
 - Based on a remote procedure call (**RPC**)
 - Define various RPC operations to improve the management functionality
- Use connection-oriented protocol for transport considering bulk data processing

Netconf Management Protocol



Defined XML Tags of Netconf



- Operation Layer
 - Base RPC Operations
<get-config>, <edit-config>
<copy-config>, <delete-config>
<lock>, <kill-session>
 - Additional RPC Operations
- RPC Layer
 - Non operations
<rpc>, <rpc-reply>
 - RPC Operations
<rpc-abort>, <rpc-abort-reply>
<rpc-progress>

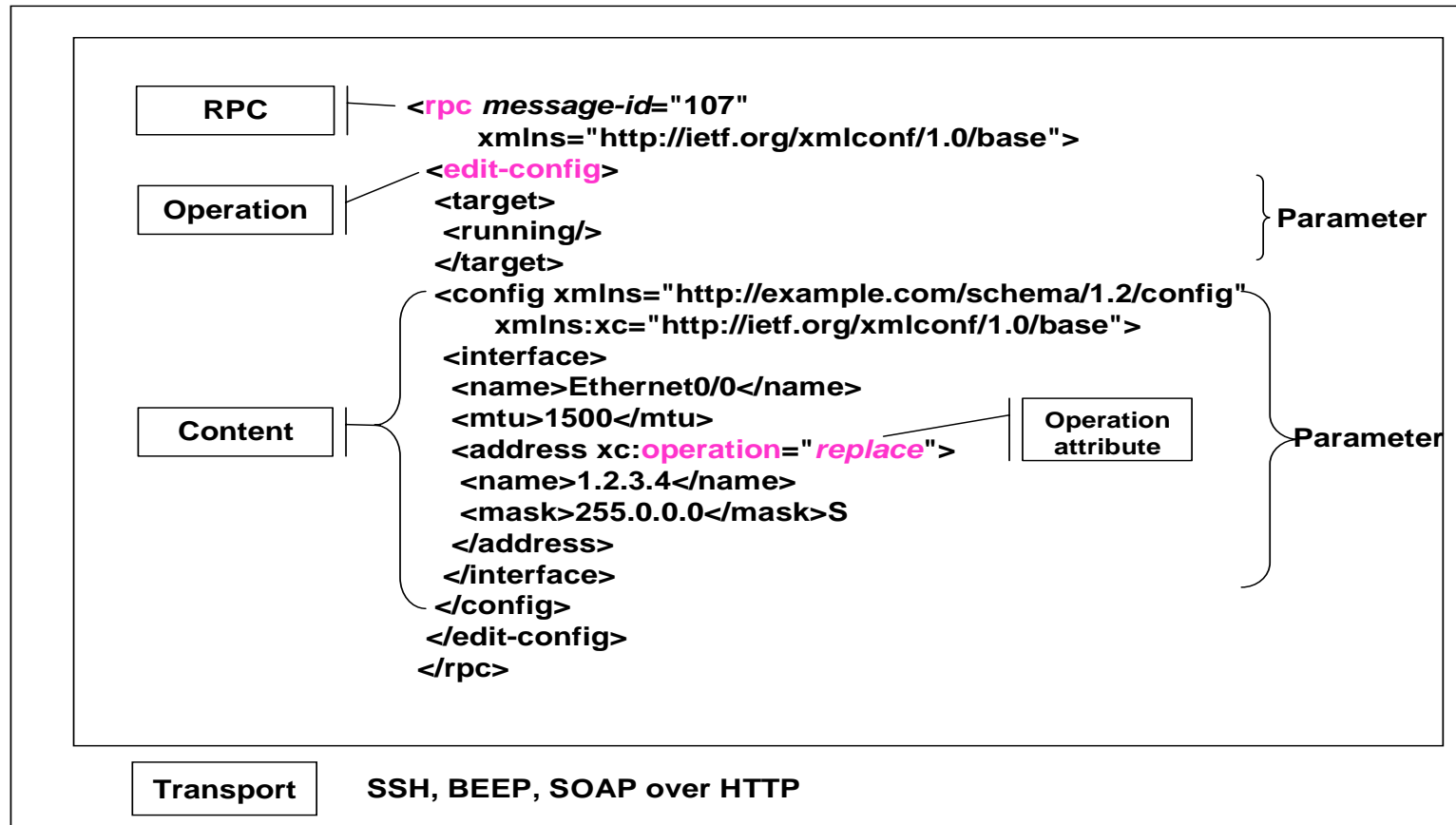
Transport Layer

- Session: the connections between the manager and the agent
- Channels
 - Operation Channel (MUST)
 - carry a series of RPCs in the NETCONF operations layer
 - Management Channel (MAY)
 - carry information of managing the NETCONF session
 - Notification Channel (MAY)
 - carry notifications from the agent to the manager

Application Protocol Binding

	SSH	BEEP	SOAP over HTTP
Management Channel	Not	support	Not
Operation Channel	support	support	support
Notification Channel	Not	support	Not
RPC Interface	Not	Not	Support
Independent-transport	Not	Not	Support
Note	Server/Client	peer-to-peer	Server/Client

<edit-config> Message



Problem in Netconf protocol

- Provide unclear layer between Operation and Content layers because of no addressing method (`<edit-config>`)
- Not support to describe RPC operations to improve management functionalities

Problem in Netconf over SOAP/HTTP (2)

- Not provide multiple channels
- Not call mandatory RPC operations by SOAP RPC interface
- Not define WSDL of RPC operations to guarantee interoperability between SOAP RPC operations

→ Management protocol using SOAP RPC needs WSDL of RPC operations

Our Solutions and Suggestions



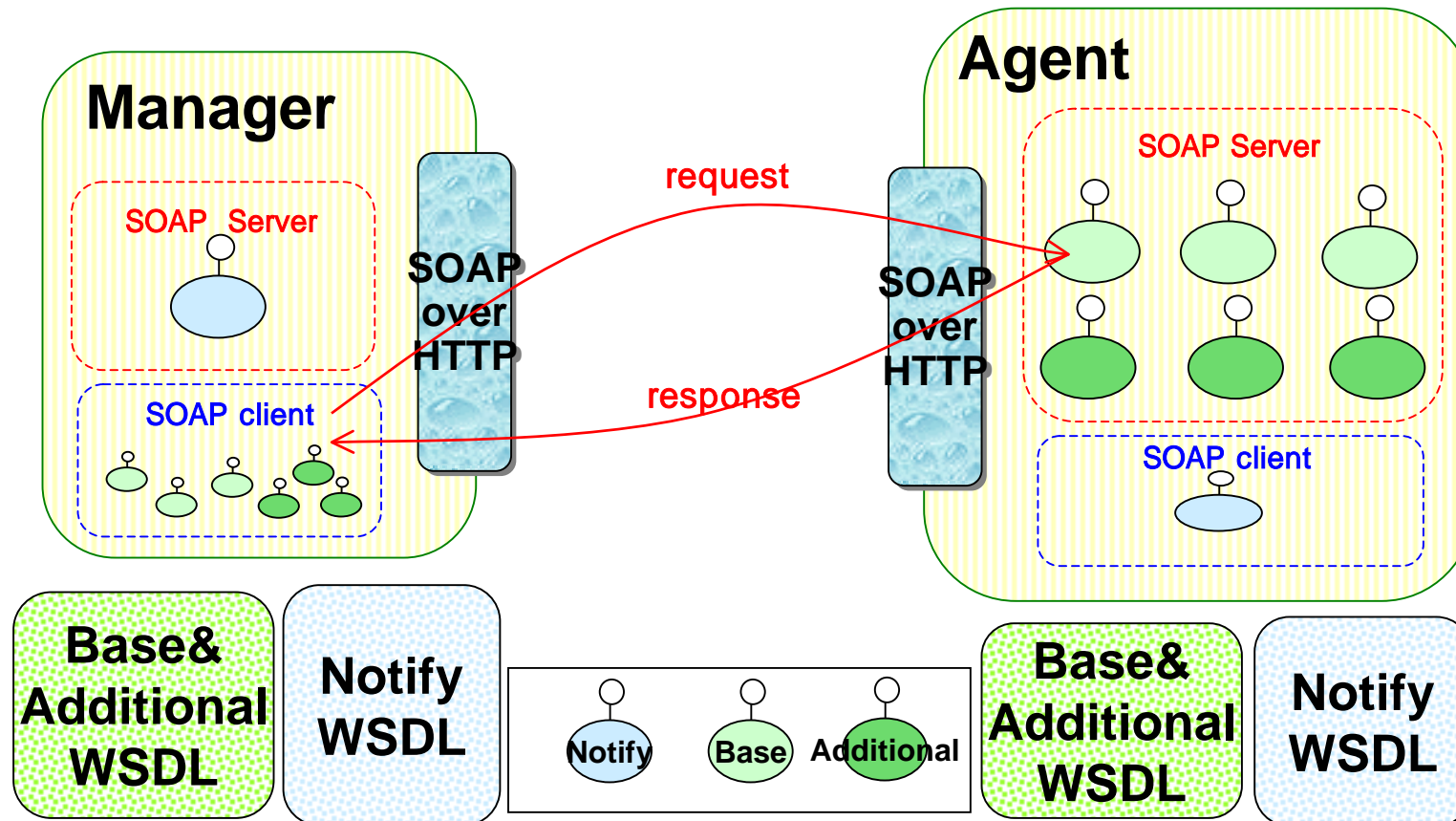
- To overcome SNMP problems
 - Suggest **management information modeling** considering relationships using XML Schema
 - Suggest **SOAP-based management protocol**
- To overcome Netconf problems
 - Use **XPath** as a addressing method
 - Suggest only XPath expressions to need in configuration management on agent aspect
 - Define RPC operations using **WSDL**
 - Include **HTTP Server/Client** to support notification channel

Management Protocol: SOAP

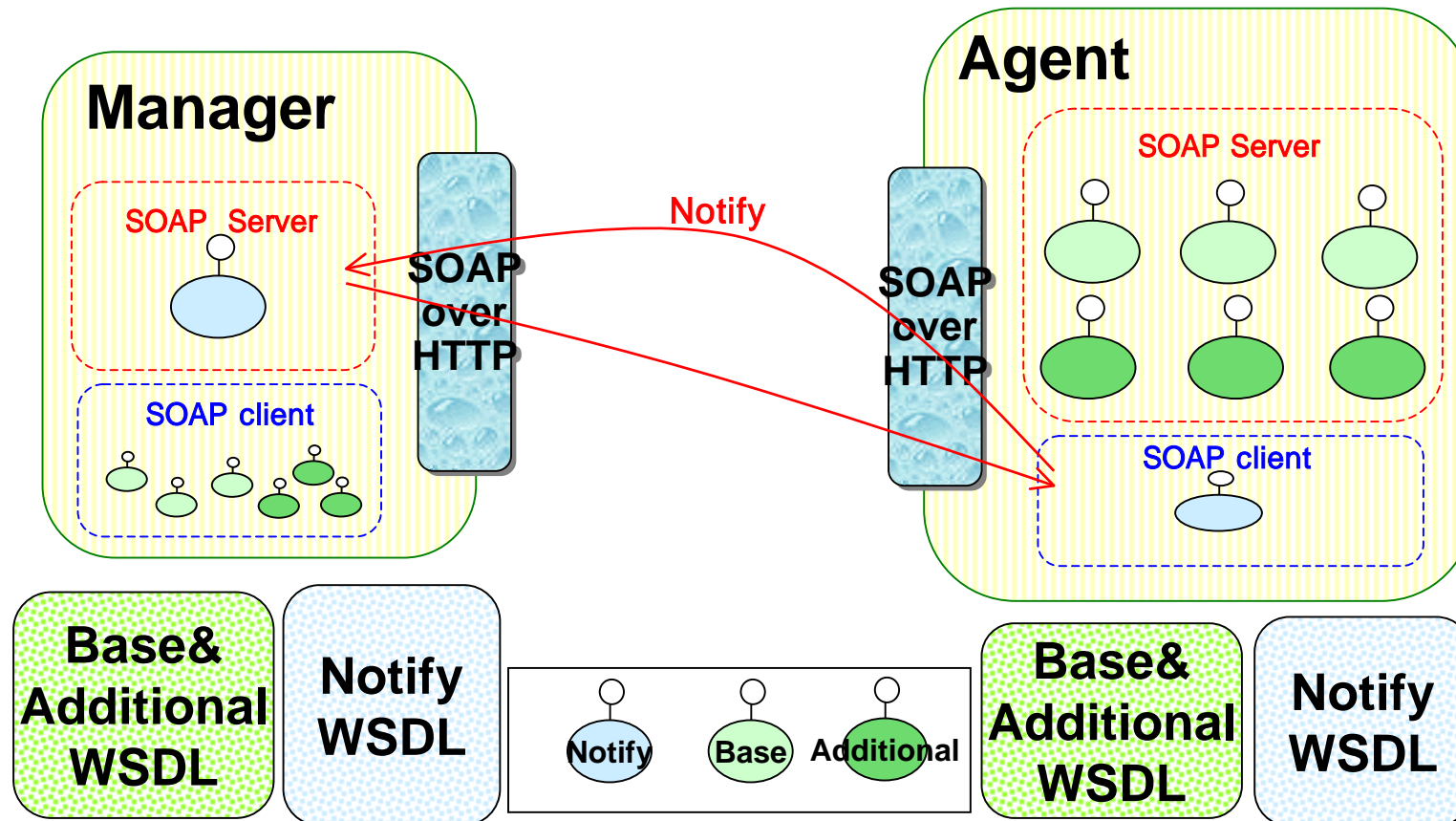


NETCONF Protocol Level	SOAP RPC Message Level	Example
Content	Parameter	<pre>//SOAP RPC Operation <SOAP-ENV:Body id= "50"> <edit-config-replace> <target> <running/> </target> <xpath> //wanset </xpath> <config> <wanset> <ip>211.171.1.1</ip> <networkmask>255.0.0.0 </networkmask> <gatewayip> 211.171.1.2 </gatewayip> </wanset> </config> </edit-config-replace> </SOAP-ENV:Body></pre>
Operation <get-config>, <edit-config>, <lock>, <kill-session>, <copy-config>, <delete-config>, <lock>, <kill-session>, etc.	SOAP RPC Operation <get-config>, <edit-config-replace>, <edit-config-merge>, <edit-config-delete>, <copy-config>, <delete-config>, <lock>, <kill-session>, <download>,<upload>, <reboot>,<shutdown>, <rpc-progress>, <rpc-abort>	} Parameter 1 } Parameter 2 } Parameter 3
RPC <rpc>, <rpc-progress>, <rpc-abort>, etc.		
Transport	HTTP	HTTP

Using SOAP RPC Interface



Using SOAP RPC Interface



Addressing Method: XPath



```
//ip[@name='primary'] | //ip[@name='second']
```

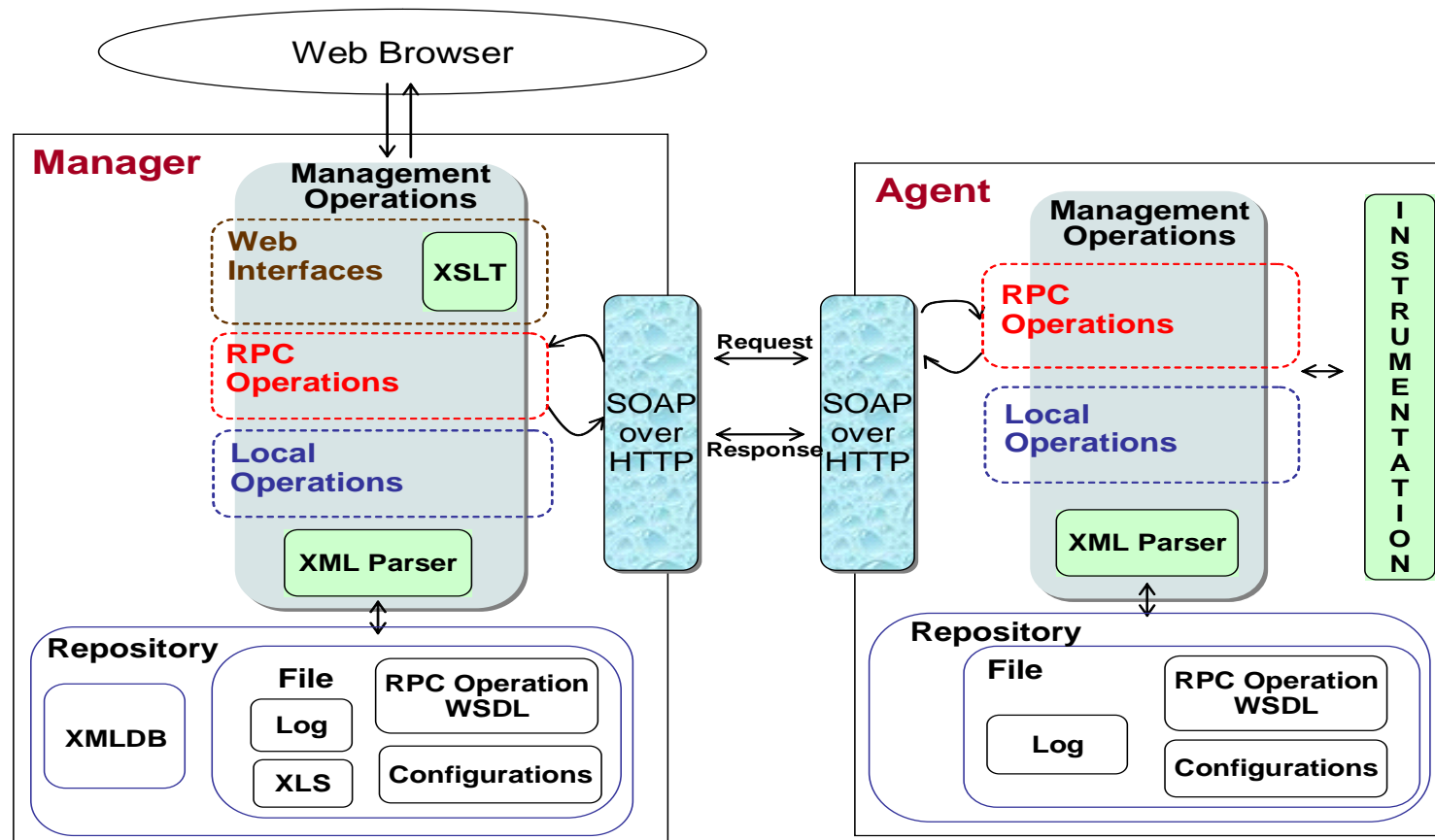
- **Node-set** is an unordered collection of nodes without duplicates
- **Operators** are used for selecting the nodes within a specific range

Management Information Modeling

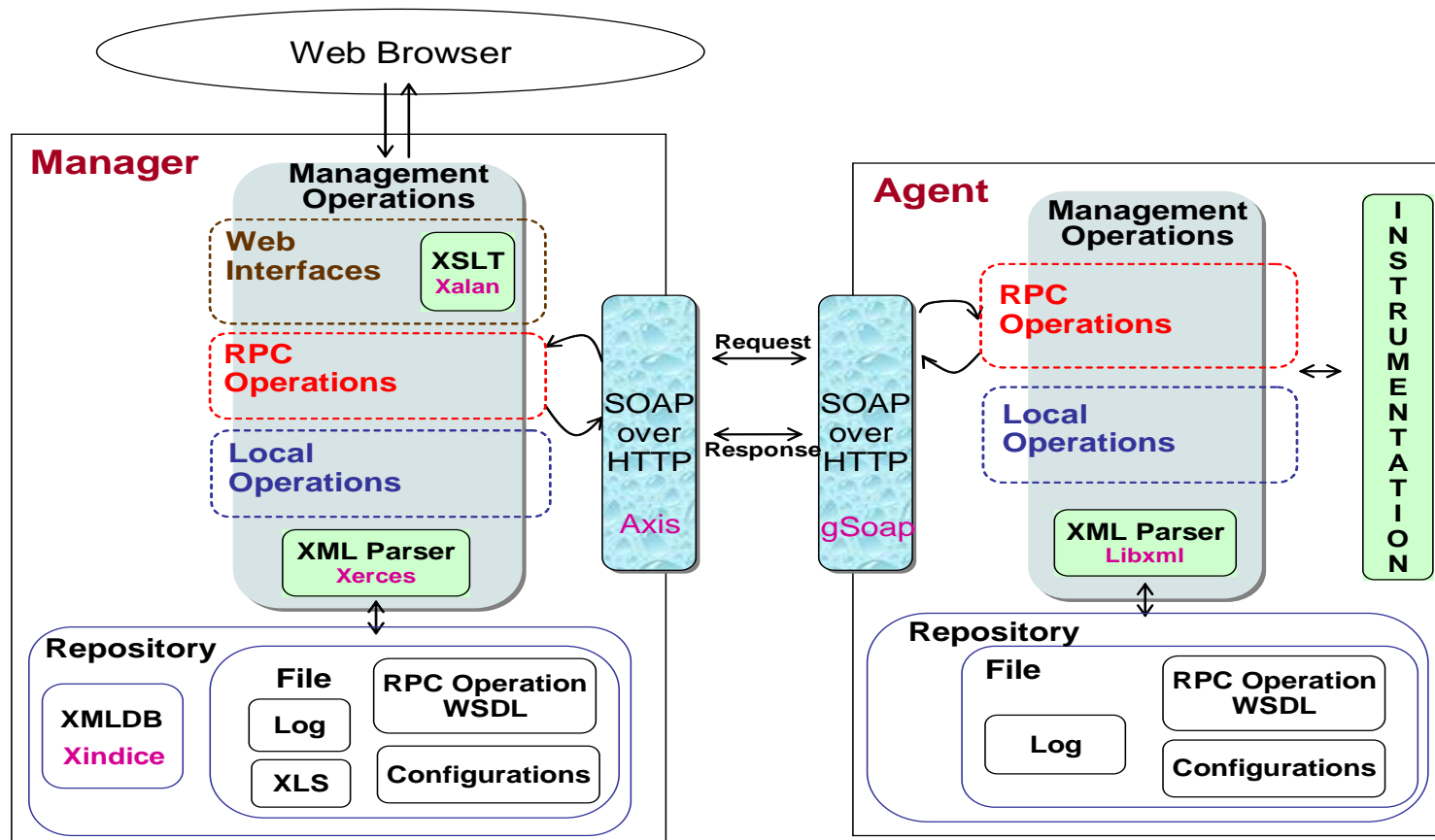
Section	Parameter	Value
basic	lan	
	ip	192.168.10.1
	networkmask	255.255.255.0
	wan	
	auto	<input checked="" type="checkbox"/> enable
	<input type="checkbox"/> disable	
wan	ip	211.171.108.16
	networkmask	255.255.255.192
	gatewayip	211.171.108.1
	dns	
dns	ip	192.168.1.1
	ip	192.168.1.2
dhcp	set	<input checked="" type="checkbox"/> enable
	<input type="checkbox"/> disable	
	startingip	155
	usernumber	30

```
<IPGW>
<basic>
<lan>
<ip>192.168.10.1</ip>
<networkmask>255.255.255.0</networkmask>
</lan>
<wan>
<auto ref='//dhcp/set'>disable</auto>
<wanset>
<ip>211.171.108.16</ip>
<networkmask>255.255.255.192</networkmask>
<gatewayip>211.171.108.1</gatewayip>
</wanset>
</wan>
<dns>
<ip name='primary'>192.168.1.1</ip>
<ip name='second'>192.168.1.2</ip>
<ip name='third'></ip>
</dns>
</basic>
<dhcp>
<set ref='//wan/auto'>disable</set>
<dhcpset>
<startingip>155</startingip>
<usernumber>30</usernumber>
</dhcpset>
</dhcp>
</IPGW>
```

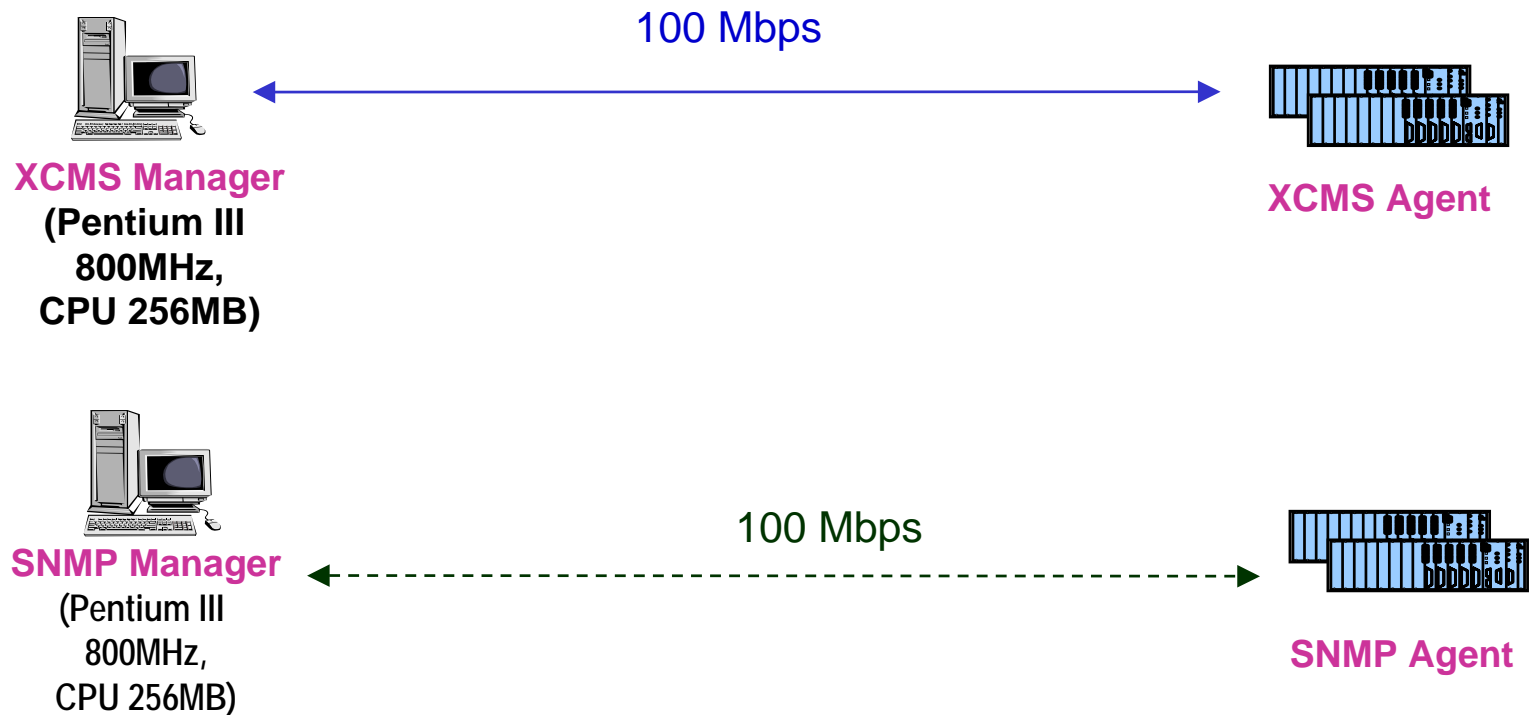
Architecture of XCMS



Implementation



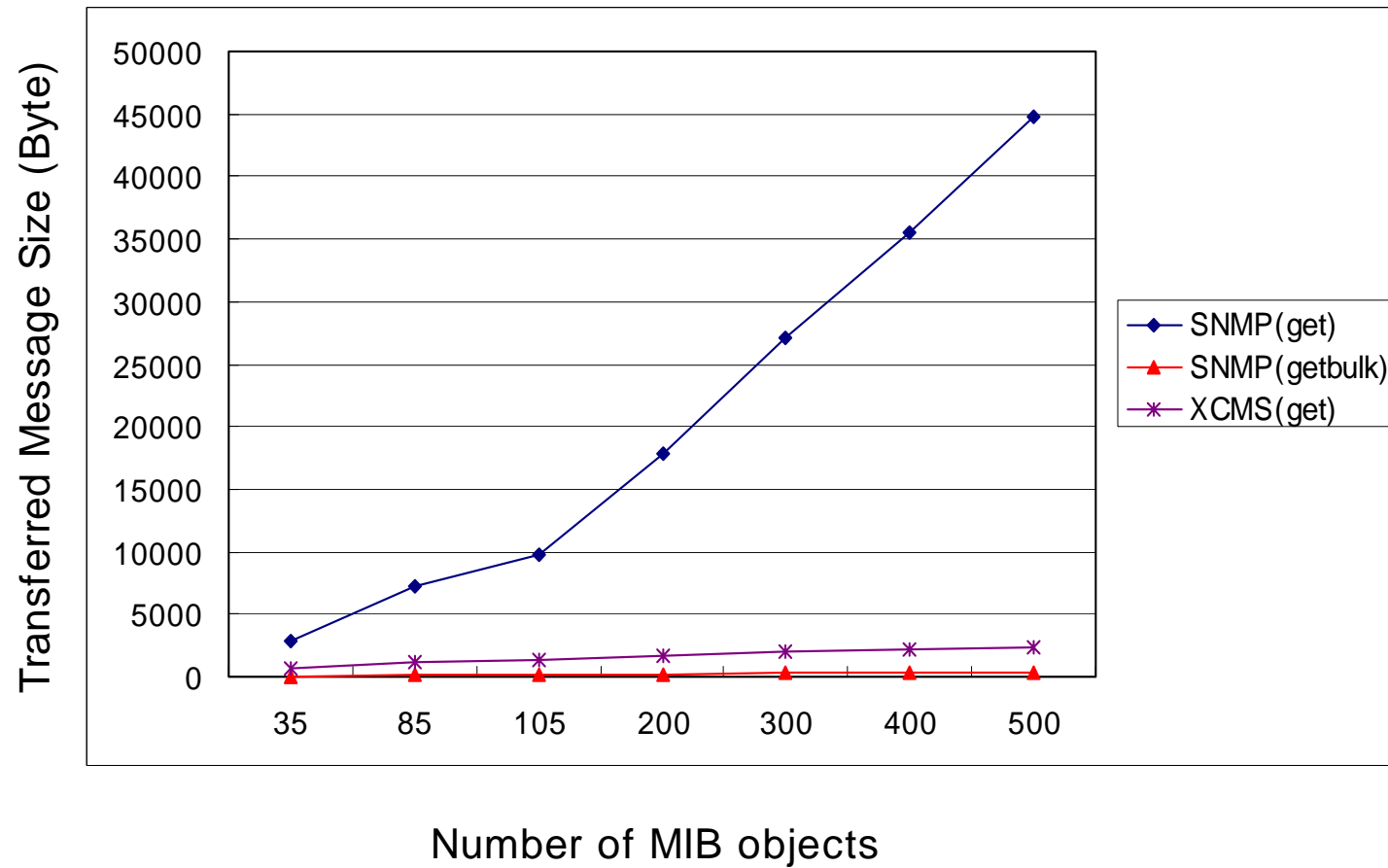
Performance Test Environment



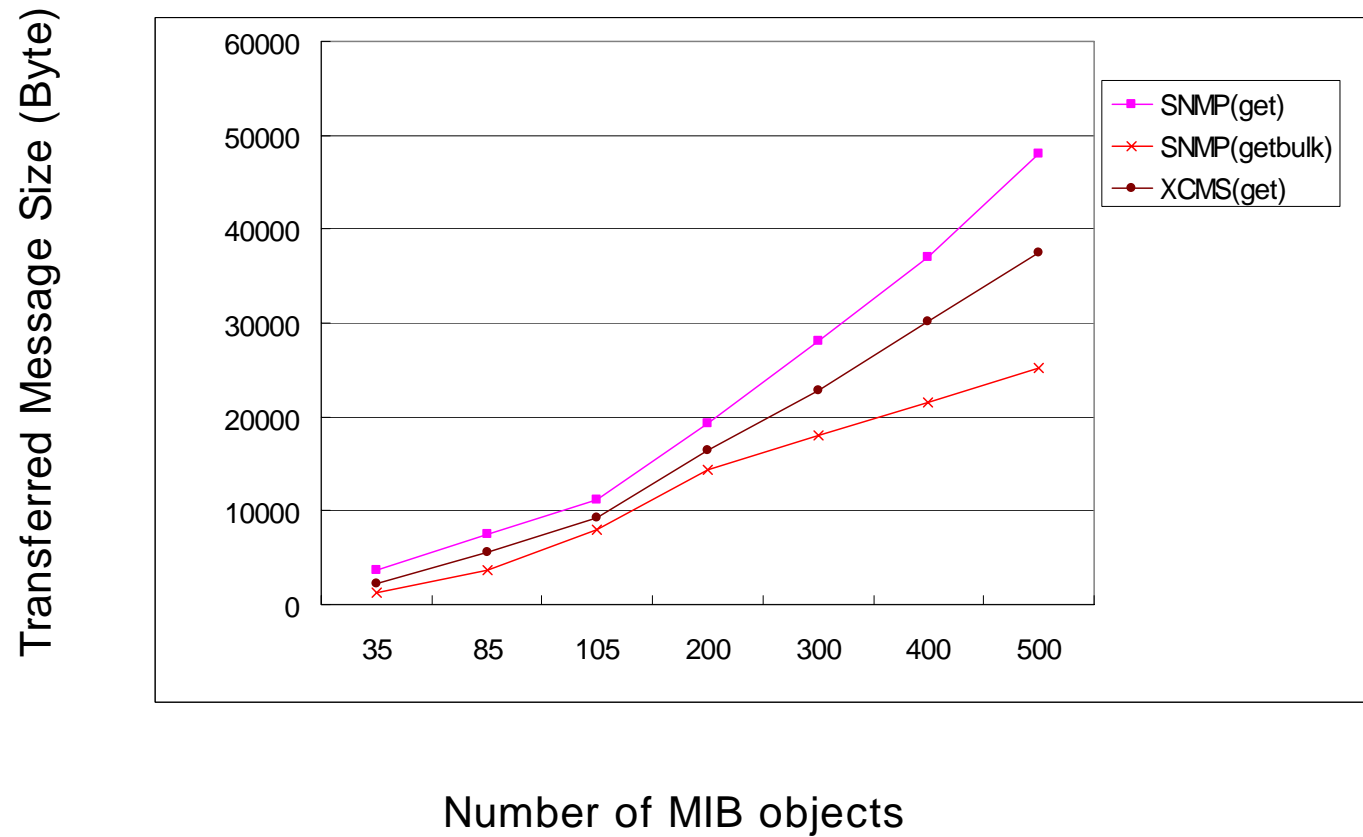
Performance Evaluation (1)

- SNMP(Get/GetBulk) vs. XCMS(get-config)
- Network traffic overhead
 - Transferred Message Size (Request & Response)
- System processing overhead
 - Packet Numbers from request to response
 - Response time from request to response

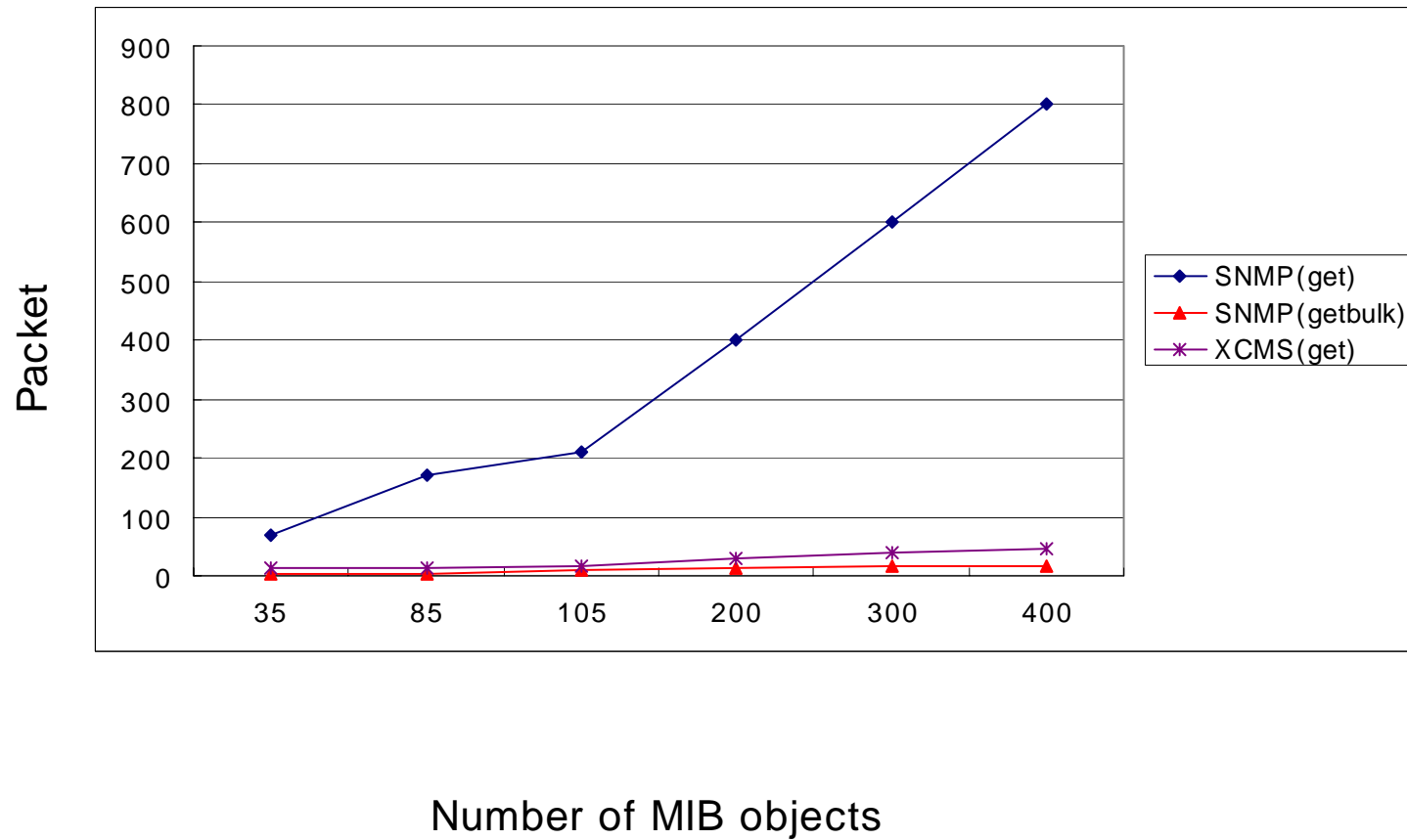
Request



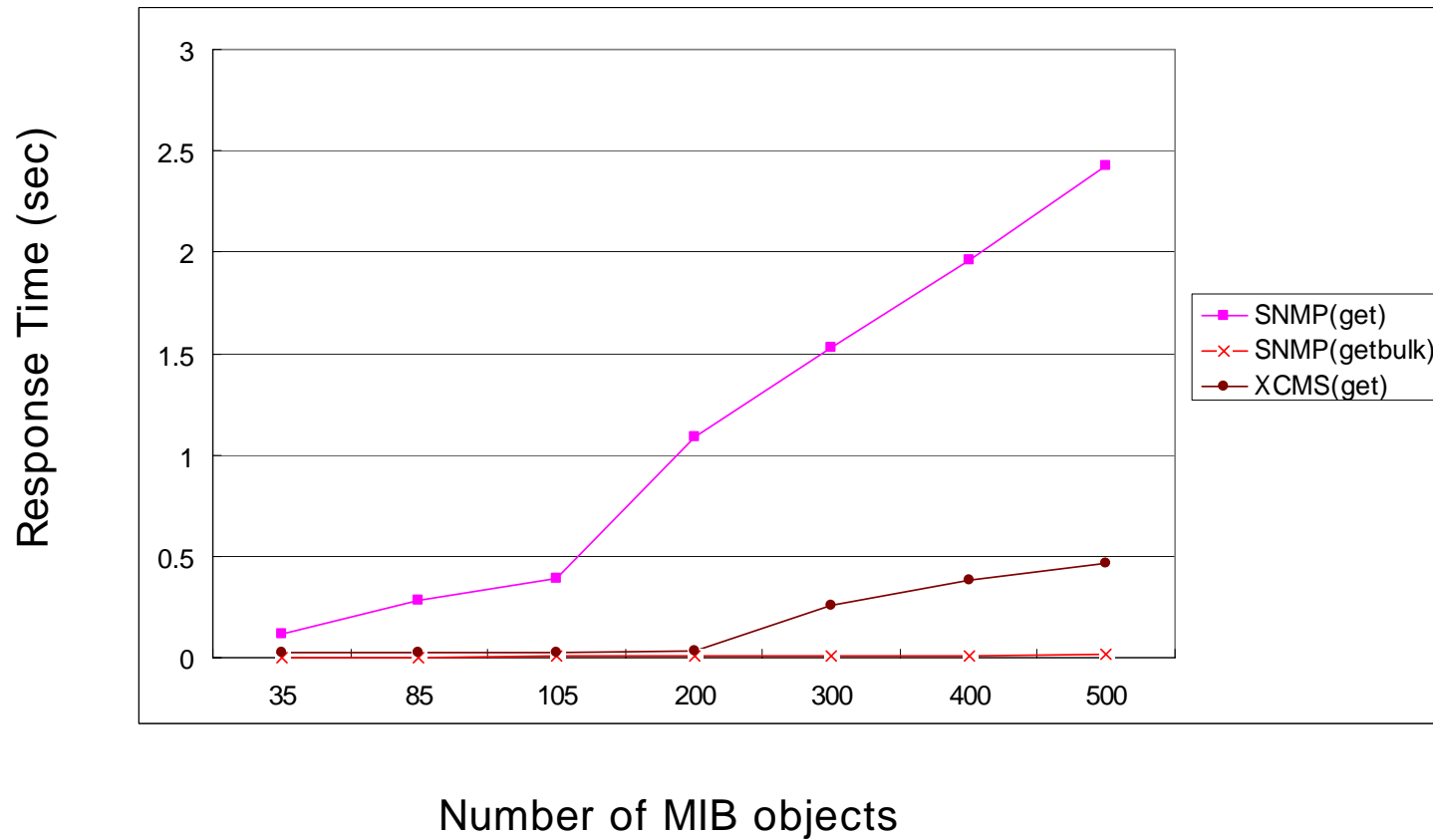
Response



Packet



Response Time



Comparison and Summary

	SNMP	Netconf over SOAP	XCMS
Bulk data	Limit (Get)	No limit (Get&Set)	No limit (Get&Set)
Extend or Modify operations	Difficult	Easy	Easiest Using WSDL
Notification	Support (trap)	Not	Support
Relationships of objects	Not	Not (Out of Content)	Support
Addressing Method	Absolute path	Not	Relative path

Conclusions

- Proposed Architecture of XML-based Configuration Management System (XCMS)
- Optimized management protocol for SOAP binding
- Provides the ease of implementation using XML technologies
- Guarantees the interoperability using SOAP RPC operations defined by WSDL

Future Work

- Further to optimize XCMS agent in an embedded system
- Plan to extend XCMS to Web Services

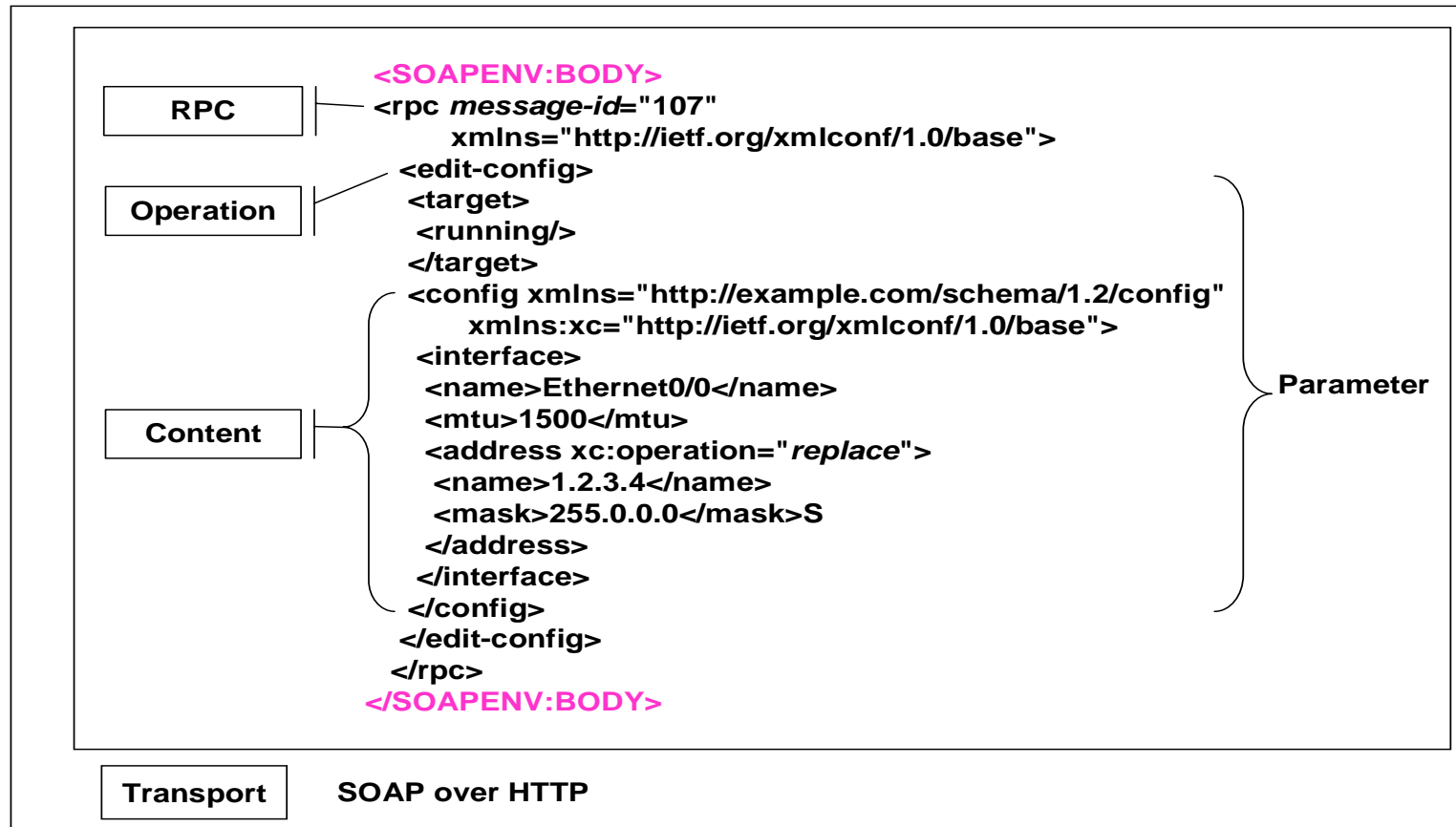
Published Papers List

- _____, _____, _____, "NETCONF XML", Accepted to appear in the KNOM Review, Vol.6, No.2, December 2003.
- Hyoun-Mi Choi, Mi-Jung Choi, James W. Hong, "Design and Implementation of XML-based Configuration Management System for Distributed Systems", Accepted to appear in the Proc. of the IEEE/IFIP Network Operations and Management Symposium (NOMS 2004), Seoul, Korea, April 2004.
- Hyoun-Mi Choi, Mi-Jung Choi James W. Hong, "XML-Based Configuration Management for Distributed System", Proc. of 2003 Asia-Pacific Network Operations and Management Symposium (APNOMS 2003), Fukuoka, Japan, October 1-3, 2003, pp. 599-600.
- _____, _____, _____, "XML", Proc. of KNOM 2003 Conference, Daejeon, Korea, May 22-23, 2003, pp. 330-337.

Thank you.!!



Problem in Netconf over SOAP



Conclusions (1)



- Management protocol
 - SOAP message is over connection-oriented protocols. This is useful for processing bulk data.
 - SOAP provides the Remote Procedure Call (RPC) interface. This easily calls new additional operations.
 - SOAP-based protocol supports to easily modify the message format.
 - SOAP tools generate the WSDL files which contain the definitions of the RPC operations.

SNMP vs. XML-based CM

- Management Information Modeling
 - XML defines various data types using XML Schema
 - XML presents the dependency of nodes
- Addressing Method
 - XPath is composed of the names of the nodes
 - XPath supports a relative path because of accessing with name of the node

SNMP vs. XML-based CM



- Management Protocol

<Request PDU>	PDU Type	Request-id	0	0	Variable bindings
<Response PDU>	PDU Type	Request-id	Error-status	Error-index	Variable bindings

<SNMP Message Formats>

<pre> <SOAP-ENV:Body id="107"> <get-config> <target> <running> </target> <xpath> //admin </xpath> </get-config> </SOAP-ENV:Body> </pre>	<pre> <rpc-reply> <config> (XML data) </config> </rpc-reply> </pre>
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<SOAP-based Message Formats>